Combining Lexical-Syntactic Information with Machine Learning for Recognizing Textual Entailment

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Machine-Learning Approach

What is *Textual-Entailment?*

Given a text *t* and an hypothesis *h* we want to define a function *e* which takes these two texts as arguments and returns an answer to the entailment question *is* h *implicit in* t*?*

e(t,h) = { *YES if* h *is implicit in* t ; *NO otherwise* }

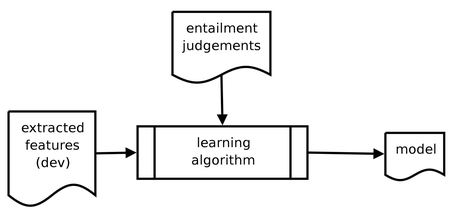
This can be approximated using Machine Learning algorithms by

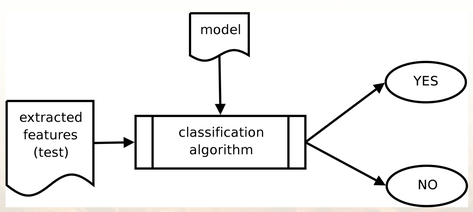
$$\hat{e}(t,h) = bc(f,m)$$

where

bc is a binary classifier
f is a set of features
m is the learned model of the classifier *bc*

Therefore, *training* has to be performed before solving entailment questions which are, with this approach, reduced to classification decisions:





Computed features

Lexical similarity

***SIM*: Simple Matching**

Semantic distance between each stem of the hypothesis and the text. When the distance is under a certain threshold, then both stems are counted as similar.

$$SIM_{matching} = \frac{\sum_{i \in H} similarity(i)}{|H|}$$

$$similarity(i) = \begin{cases} 1 & if\ \exists j \in T, s_L(i,j) > 0.5 \\ 0 & otherwise \end{cases}$$

where
s_L is the Lin's similarity measure
H and *T* are the hypothesis and text sets of concepts respect.
i,j are two concepts (WordNet's synsets)

***BM*: Binary Matching**

Same as previous but:

$$similarity(i) = \begin{cases} 1 & if\ \exists j \in T, i = j \\ 0 & otherwise \end{cases}$$

***CSS*: Consecutive Subsequence Matching**

Counts the number of consecutive subsequences of stems that appear in both pieces of text.

***Trigrams*:**

Same as before, but using words instead of stems and only on subsequences of three words.

Syntactic similarity (*SynTree* features)

We computed a set of measures from the syntactic trees obtained with COLLINS from both texts. *Aligned* terms are identified (those stems appearing in both texts), and then, also with the POS information of the parsing, we compute:

1. Number of aligned terms
2. Number of coincident POS of aligned terms
3. Number of unmatched POS of aligned terms
4. Minimal, maximal and average of distances differences in nodes through the syntactic trees to go from one aligned term to another

Experimental results

We have performed 6 different experiments, applying combinations of described features and two possible learning algorithms: BBR and TiMBL

SIM	BM	CSS	Trigrams	SynTree	Classifier	Accuracy
X		X	X	X	BBR	0.6475
X	X	X	X	X	BBR	0.6462
X		X	X		BBR	0.6387
X	X	X	X		TiMBL	0.6062
X		X	X		TiMBL	0.6037
X		X	X	X	TiMBL	0.5700

Conclusions and future work

Good results areobtained integrating all features, but lexical ones seem to hold better information, being the most crucial feature the simplest one: *trigams* weighting.

We plan to combine the output of several classifiers (like also SVM) to produce a single answer. Also the syntactic information has to be studied in deeper detail. Besides, a model working at semantic level is under implementation.

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